



Missouri Section ARES®  
Digital Data  
Communications Resource  
Guide



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Missouri Section ARES®  
Digital Data Communications Resource Guide 2020

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## **Purpose**

The intention of this document is to provide guidelines and suggestions for amateur radio operators, in the use of digital data communications when providing emergency communications for the the State of Missouri Emergency Management Agency (SEMA), American Red Cross, Salvation Army, National Weather Service, and other public service and disaster relief organizations.

## **Objectives**

- To promote the use of advanced digital data technologies, techniques, strategies and best practices in support of agencies and organizations served by Missouri ARES
- To document standard hardware and software commonly available to amateur radio operators
- To create a list of digital modes and protocols deemed effective in emergency amateur radio communications consistent with the requirements of served agencies.
- To encourage use of this document as a tool for development and establishment of Section-wide interoperability through ARES partnerships and links
- To update this document to reflect future technological innovations in amateur radio.

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### **Concept of Operations**

Served agencies and event organizers typically require that a significant amount of data be compiled and transferred between agencies, reporting points along a route, or temporary facilities. The effective and rapid transfer by radio of detailed lists and forms is best handled by digital data communications.

The digital data modes and techniques described in this document are intended to assist ARES responders in selecting and implementing the most effective and reliable communications modes and networks to fit the situation. In many instances the most effective network for a given mission may require the use of various national or regional amateur radio digital networks or the use of a national governmental agency program such as SHAredRESources (SHARES). Amateur radio digital data networks and the SHARES governmental program will be addressed later in this document.

Interoperability is required for a local operation to effectively communicate regionally or nationally. The informed choice of an interoperable network and digital data mode will, in large measure, determine the success or failure of the desired outcomes.

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### **Digital Data Modes, Hardware and Software**

A general agreement throughout Missouri Section ARES regarding the standardization of digital EmComm modes is needed to prevent the potential collapse of intended interoperability. Because no single mode or combination of modes can satisfy all requirements in every situation, it becomes incumbent upon ARES leadership and responders to develop and utilize the best digital tools for the radio and administrative environments in which they operate.

The modes described below have been shown to be effective for ARES EmComm use and *are* currently in use by various EmComm practitioners and served agencies throughout Missouri. The list below reflects preference given to programs and modes offering keyboard to keyboard communications, file attachments, embedded ICS forms and special forms created specifically for governmental and non-governmental (NGO) use. An advantage of using digital modes is the ability to print messages or to cut and paste the text into a document that can be provided to the served agency for immediate action, archive or attachment to official documents.

The accuracy of message content is obviously important and some of the digital modes offer error correction (ARQ). The use of error correction increases accuracy but may result in inordinate amounts of time consumed in retransmissions during adverse band conditions. Under these conditions the ARES operator may have to decide if enough message content can be received without invoking ARQ protocols.

The digital modes covered in this document are provided for guidance only. It is not the intention to endorse any given mode, hardware or software but rather to provide a list of those modes and operational procedures that have proven effective over time.

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### A. Packet

Packet radio can be used to establish direct simplex or digipeater-assisted data communications links between served agencies.

Packet offers peer-to-peer keyboard-to-keyboard chat and the use of 'mailboxes' embedded in the Terminal Node Controller (TNC) to leave messages for retrieval. Packet transmissions are seen as plain text by all Packet stations on the frequency which can be useful for 'broadcast' style bulletins or messages to multiple sites but might not be a desired feature for certain kinds of transmission.

Typical EmComm applications include simplex or digipeater links between state and local EOCs, NGOs such as American Red Cross and Salvation Army, community shelters, hospitals, ARES leadership for command and control, and other fixed post assignments. Packet is one of the modes that may also be used to access the Winlink system. However, terminal emulation programs such as *HyperTerminal* and *Tera Term* cannot be used to successfully 'complete' a Winlink transaction.

#### Software:

*HyperTerminal* and *Tera Term* are among rudimentary computer programs used with Packet. Past versions of *HyperTerminal* work fine and were free but current versions require a purchase. *Tera Term* is freeware. A number of advanced multi-mode software programs such as *HamScope and Outpost Package Message Manager* and PuTTY are available as freeware on the Internet. In addition, some manufacturers provide software for use with their hardware TNC.

Software TNC programs are also available for packet applications relieving the user from buying a hardware TNC. Two such programs are DireWolf, and UZ7HO. These programs use sound card applications to emulate hardware TNCs.

#### Hardware:

An external Terminal Node Controller (TNC) is required between the computer and the radio unless the radio has a built in TNC. Typical TNC manufacturers are Kantronics, Timewave and MFJ Enterprises. Individual configurations of Packet setups are beyond the scope of this document.

#### Operational tips:

Packet may be used on VHF, UHF or HF. VHF and UHF installations are much more common and generally provide more reliable links than HF. VHF/UHF packet RF transmissions typically occur at 1200 baud which is generally adequate for text messages. HF packet can be used successfully but is subject to all the normal issues associated with operation on the HF bands such as noise, fading, and interfering signals, even at a very slow 300 baud rate.<sup>1</sup>

New conventional TNCs are not extremely expensive and used TNC's can often be found at hamfests and swapmeets at very affordable prices.

<sup>1</sup>S. Ford, ARRL VHF Digital Handbook, First Edition, p 1-7

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### B. FSQCall

FSQCall, (FSQ), is a digital mode specifically designed for public service and disaster Near Vertical Incidence Skywave (NVIS) communications on HF. Unlike other ubiquitous digital modes, FSQ has features that are unique and especially useful for EmComm applications. A short list of features relevant and useful for EmComm include:

- Send an alert to a specific station
- Read a station's pre-defined message
- Find a station's location
- Send a message to just one station
- Send a message to all stations within range
- Read a station's recently heard list
- Poll a station to check reception
- Periodically sound (ID)
- Initiate automatic relays through other station(s) to reach stations which are otherwise unable to establish contact or to maintain contact.
- Adjustable transmit data rate to compensate for unfavorable band conditions

#### Applications to EmComm:

Base operations such as emergency operations centers and hospitals, or temporary fixed sites such as shelters.

#### Software:

FSQCall V0.24.6 <http://www.qsl.net/zl1bpu/MFSK/FSQweb.htm>. A compatible version of FSQCall is available within the Fldigi software suite. The current version of Fldigi with FSQ embedded may be found at <http://www.w1hkj.com/>

#### Hardware:

A soundcard such as a SignalLink USB or RIGblaster with proper cabling to radio.

#### Operational tips:

Since FSQ messaging is open text the information passed on the air serves to inform all users on specific local, regional and statewide activity during disasters and exercises. Information transmitted between venues may be used to provide situational awareness to local emergency managers. FSQ may also be used to provide messaging between emergency management venues and other supported agencies.

Additional details regarding FSQCall and the Fldigi FSQ mode may be found at the following websites:

<https://ares-mo.org/plans/>

[https://www.whitemesa.net/fsqcal/doc/FSQCAL\\_024\\_6\\_US/CALLhelp.htm](https://www.whitemesa.net/fsqcal/doc/FSQCAL_024_6_US/CALLhelp.htm)

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### C. Winlink Express

Winlink Express. (Winlink), is a radio e-mail client program with worldwide connectivity. Winlink provides amateurs with the means to send and receive error free emails, photos, ICS forms, customized forms via radio or the internet and SMS messages to smart phones<sup>(1)</sup>. Senders and recipients need not be connected to Winlink servers simultaneously to move traffic.

Users may send messages and attachments to any amateur call sign registered with Winlink and to any regular email account. *TIP: Email accounts attempting to contact a Winlink account holder will be rejected unless a message has been sent to that email account via Winlink from the Winlink account holder first, or the first time sender knows to put “//WL2K” in the subject line of the email.*

#### Applications to EmComm:

Served agencies rely heavily on email. In the absence of local internet service ARES operators can use Winlink RMS stations to establish radio email and messaging service. ARES operators can use their HF, VHF or UHF radios to connect to Winlink Radio Message Server (RMS) stations located domestically and around the world. For regional operations, amateurs using a regional RMS can conduct strategic and tactical communications through that hub without the need for internet. Likewise, Winlink’s peer-to-peer feature provides direct communications between two stations within range of one another or, if using Packet, through a digipeater. A high speed VARA mode session on Winlink is one of the fastest traffic throughput modes available using sound card modes.

Winlink maintains an internal library of HTML fillable templates (forms) such as ICS forms, ARRL Radiograms, and various public safety and non-governmental (NGO) forms. These ready-made templates (forms) increase efficiency in served agency messaging.

#### Software:

Winlink client software, which includes the various sound card and hardware modes, is free and is available from <https://downloads.winlink.org/User%20Programs/>. Download [Winlink Express install 1-5-26-0.zip](#) and [Winmor TNC install 1-5-13-0.zip](#) to get started.

The Winlink client software is used in conjunction with the free VOACAP (ITSHFBC) propagation prediction software which can be downloaded separately from <http://www.greg-hand.com/versions/>. Alternatively, the Winlink program will download and install the VOACAP program for you when you access the RMS channel list if it has not been previously installed on your hard drive or can’t be found on your computer by Winlink. The VOACAP program runs seamlessly in the background to provide reasonably accurate estimates of probable connectivity to listed RMS stations in real time. The latest propagation predictions may be downloaded via internet or radio within the Winlink program.

Embedded Winlink modes include Winmor, Packet, Pactor, ARDOP, VARA, Telnet and others. The modulation scheme of each mode largely determines whether a sound card interface or a hardware modem is required for operation.

VARA mode requires the VARA software program to work with Winlink. VARA software is not provided by Winlink. VARA is available at <https://rosmodem.wordpress.com/>. A freeware version of VARA is available but the higher speed (HF, FM) version of this program costs approximately \$70.00.



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The RMS Express software suite can be run in Linux under the Wine MSWindows emulation software (details at [https://www.winlink.org/sites/default/files/downloads/installing\\_rms\\_express\\_on\\_linux\\_with\\_wine.docx .pdf](https://www.winlink.org/sites/default/files/downloads/installing_rms_express_on_linux_with_wine.docx.pdf)). An additional software option for Linux operators is a program called "PAT Winlink" (available from <http://getpat.io>) along with the "ardopc" modem software (available from <http://www.cantab.net/users/john.wiseman/Documents/ARDOPC.html>).

### Hardware:

A computer with keyboard and mouse, a TNC or sound card modem, a radio for the HF, VHF or UHF bands and appropriate antennas are all that is needed to run Winlink..

The choice of a Winlink communication mode determines the modem needed. Each Winlink mode offers drop down menus to select the radio and TNC or sound cards to be used with that mode. Sound card modes would include WINMOR, ARDOP, and VARA but Packet operation will require a hardware TNC, virtual TNC or TNC-equipped radio. Pactor level III will require a proprietary SCS brand modem such as the PTC III, DR-7400 and DR-7800 models; <https://www.p4dragon.com/en/Home.html>

### Operational tips:

Winlink's Winmor is a commonly used sound card mode but the ARDOP and VARA modes are significantly faster, 4,000 and 7,000 bps, respectively <sup>(2)</sup>. Winmor will be gradually phased out in favor of faster modes according to Winlink.

Packet mode is a popular method of using Winlink on the VHF/UHF bands. The use of digipeaters extends the range from which connection to an RMS can be made. Fixed or portable digipeaters can be employed to overcome terrain impediments.

Pactor operation is considerably faster than Packet or most sound card modes, the VARA sound card mode being an exception as noted above. Pactor III (5200 Bits/sec) is the preferred mode due to its significant speed advantages and reliability in noisy and weak signal conditions. Pactor IV modems (1.5-3.5 times faster than Pactor III) are available and preferred for use on governmental frequencies. The FCC does not currently authorize Pactor IV for use on the amateur bands. Legacy Pactor I and II modes are seldom used today.

Winlink also offers peer-to-peer (P2P) and 'radio only' messaging modes for direct communications without the use of the Internet.

- Peer-to-Peer (P2P): direct connection between two stations without the use of internet
- Radio-Only - This mode relies solely on radio to connect to a radio Message Pickup Station (MPS) where messages to and from your station are stored and forwarded. Radio-only mode requires each participating station to have previously assigned two or three MPS stations where their messages are stored to be forwarded or retrieved. Reliable connectivity to the chosen MPS stations should be determined before assigning them. Messages sent to recipients not using the same MPS are routed over the Winlink system via radio to the intended recipient's MPS. This may take minutes or days depending on HF propagation.

Telnet mode allows the user to connect directly to Winlink over the internet. No radio is used. Telnet is obviously the fastest method of connecting to Winlink and, if internet is available, negates the need for

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a radio link. Information transferred via Telnet could be then be forwarded to served agencies by radio or other means as necessary.

The Winlink client software, is used by federal, state and local governmental agencies on non-amateur frequencies for virtually the same reasons used by ARES members on the amateur bands. Therefore, ARES members embedded with these agencies should become familiar with the many features offered by this program, including the use of SCS Pactor III and Pactor IV modems.

There are many possible Winlink setups, such as the use of tactical callsign addresses, and networking configurations that would add value to EmComm operations but are beyond the scope of this document.

<sup>(1)</sup> <https://www.digitaltrends.com/mobile/how-to-send-a-text-from-your-email-account/>

<sup>(2)</sup> [http://www.commacademy.org/2019/S21-Digital\\_Sound\\_Card\\_Modes\\_for\\_WinLink-Currie/S21-Digital\\_Sound\\_Card\\_Modes\\_for\\_WinLink-Currie.pdf](http://www.commacademy.org/2019/S21-Digital_Sound_Card_Modes_for_WinLink-Currie/S21-Digital_Sound_Card_Modes_for_WinLink-Currie.pdf)

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### D. Fldigi

The Fldigi program is a component of the Narrow Band Emergency Messaging System (NBEMS). Fldigi offers a variety of sound card modes such as CW, RTTY, PSK, Olivia, MT63, FSQ and many more. Text files, CSV files, ICS forms and custom forms such as the Missouri WEBeoc Resource Request Form for ham radio created by W0KAH can be sent and received when Fldigi is coupled with the Flmsg program. Fldigi can be used with SSB or FM radios on HF/VHF/UHF bands.

#### Applications to Emcomm:

Fldigi is ideally suited for Emcomm because of its low investment in hardware and software, its ease of use and its widespread use among amateur radio operators. The program suite is well suited to send detailed lists and critical information such as lists of evacuees, road conditions, sit-reps of impact areas, .csv spreadsheets of inventories and other administrative communications using its built-in forms, imported custom forms or plain text forms. Keyboard-to-keyboard chat provides for quick messaging.

#### Software:

Fldigi software and additional software programs such as Flrig, Flmsg, and Flamp are free and can be downloaded at [www.w1hkj.com](http://www.w1hkj.com) and at <https://sourceforge.net/projects/fldigi/> Versions are available for Windows, LINUX and MacOS operating systems.

Flrig: Though not required, Flrig can be used to control the transceiver and is available as a free download at [www.w1hkj.com](http://www.w1hkj.com) and <https://sourceforge.net/projects/fldigi/>

Flamp (Amateur Multicast Protocol): Enables the Fldigi user to send multiple files from a queue to many recipients simultaneously. The files are sent in blocks and any missing blocks are reported by the receiving stations back to the sender. The sender can then resend only the missing blocks.

Flmsg (Fast Light Message): Flmsg is a messaging and forms manager with embedded, updateable NBEMS forms templates. Flmsg can be used in standard or ARQ modes. Flmsg in standard and ARQ modes can be used to leave messages with unattended stations that are on the air and running the program.

Flmsg in ARQ mode: Emphasis is placed on the ARQ in its name (automatic repeat request). Flmsg in ARQ mode is used with Fldigi to send error-free messages. As mentioned in the introductory paragraphs, the use of error correction increases accuracy but may result in inordinate amounts of time consumed in retransmissions during adverse band conditions. When used in ARQ mode, data integrity is 100% for all messages successfully sent, so is appropriate for sending critical data.

#### Hardware

Fldigi uses the sound card in your PC or an external sound card such as a Signalink, RIGblaster or other USB audio interfaces (including built-in audio interfaces in newer radios).

#### Operating Tips

Some modes available in FLDIGI are more robust than others. Experience throughout the Emcomm community has shown that FSQ, MT-63, Olivia and MFSK16 are among the modes well suited for ARES operations.

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Recommendations for various band conditions:

- Thor22 or MFSK32 in good conditions
- Thor16, Thor 11 or MFSK16 for average conditions
- Thor 8, MFSK 11 or MFSK 8 for poor conditions
- For extremely good conditions, with no QSB or static crashes, the PSKR and 8PSK modems work well, and are very fast.

Recommended procedure to implement Flarq with Flmsg:

- 1) Fldigi – TxID/RxID enabled, 700 Hz on the waterfall (if simultaneously using 1500 Hz for FSQ chat). *Note: Open Fldigi prior to opening Flmsg*
- 2) Open Flmsg. If the Simple User Interface appears with only File and Tools tabs, select Tools-Expert Dialog. The Expert User Interface now appears. Then select Config-User Interface-UI tab-and check 'expert' box. The Expert User Interface will now automatically appear when opening Flmsg.
- 3) Flmsg – Select desired form and compose message, save as file (Ex: NBEMS-ICS-MESSAGES)
- 4) Flmsg – Hit 'Autosend' at top of form to transmit the message without engaging ARQ (only recommended for non-critical messaging – use Flmsg in ARQ mode for critical messaging).
- 5) Flmsg in ARQ mode - Select mode of choice at bottom of form, enter call sign of recipient station in box at bottom of form to right of ARQ, depress 'Send' button – Disconnects from other station after transmission is complete or ARQ fails after the number of trys set up in Flmsg ARQ settings.

The following is recommended regarding the reduction of transmitter output: The radio itself should be set to 100% output power in its internal menus, then the audio drive from the PC/audio-interface should be set so that no more than 25% of maximum output power is obtained (e.g., drive the audio on a 100W radio to 25W or less). This insures that the ALC won't become active, and avoids clipping the audio and the generation of spurious sidebands.

Recommended configurations for Fldigi, Flmsg and Flarq and setting up multiple instances of Fldigi can be found at <http://joe.council.biz/modes/> then choose: MO\_FSQcall\_Traffic\_Procedure\_v10.pdf. Although this document is FSQ-centric there is a wealth of Fldigi general setup and operational details to assist users.

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### E. APRS - Automatic Packet Reporting System

APRS is a digital communications protocol for exchanging information among numerous stations covering a large (local) area. Data can include object [Global Positioning System](#) (GPS) coordinates, [weather station](#) telemetry, text messages, announcements, queries, and other [telemetry](#). All this APRS data can be displayed on a map to provide emergency management staff with status updates at a glance.

#### Application to EmComm:

Whereas, WB4APR envisioned the APRS system as a "Packet Reporting" system, it has become the "Position Reporting" system for most hams. When equipped with a GPS receiver the APRS mobile station will report its position to the APRS listeners (including a network of digipeaters) where these positions can be displayed on a computer map in real time. The EOC, equipped with such a station can be aware of the locations of all the radio operators in the field as they move and take up new positions. Additionally, short text messages can be sent to specified stations via the APRS network.

#### Software:

Mapping software displays the locations of the received APRS stations on the computer monitor. Map databases have been issues in the past. Today the software PinPoint, receives data from the TNC and shows its location on a map with good variable displays. It will also provide digipeating, and I-Gating if desired, as well as produce APRS packets to broadcast the fixed location of the mapping station. This software could be deployed on a laptop computer with APRS radio equipment to give the mobile user a map display in the vehicle to aid in finding others in a deployment. There are also some Smart-Phone apps which will send and receive location information to APRS.fi as if it were an APRS radio station.

PinPoint software is freeware and can be downloaded at <http://pinpointaprs.com/download.html>

#### Hardware:

The APRS infrastructure comprises a variety of Terminal Node Controller (TNC) equipment put in place by individual amateur radio operators. This includes sound cards interfacing a radio to a computer (software TNC), simple TNCs, and "smart" TNCs. The "smart" TNCs can determine what has already happened with the packet and can prevent redundant packet repeating within the network. Some VHF radios come with internal TNCs and APRS software to decode the APRS packets as they are received and display the basic data in those streams on the radio display.

Some amateur radio clubs have built stand-alone APRS Trackers which consist of a 2M handheld radio, GPS receiver "puck," Gel-Cell battery, mag-mount antenna and APRS controller from Byonics, <http://www.byonics.com/aprs>, all installed in a weather proof case for rapid deployment. These trackers can be placed on any vehicle to have its location shown on the APRS computer maps.

#### Operational Tips:

The standardized operating frequency for APRS in the US is 144.390 MHz FM. A mobile station should not expect to be in an APRS network when out-of-range from an APRS digipeater and APRS-IS gate. Parameters for setting up a good working APRS station are beyond the scope of this document. Good references can be found at [www.aprs.org](http://www.aprs.org), and locally, in the St Louis Digital Operations manual at [http://www.stlares.org/Docs/STLMETRO-Digital-Operations-Manual\\_v1\\_2.pdf](http://www.stlares.org/Docs/STLMETRO-Digital-Operations-Manual_v1_2.pdf).

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A local Amateur Radio community should deploy an APRS digipeater to increase the coverage of the mobile APRS stations, much as a voice repeater increases the coverage for mobile radio usage. But too many local digipeaters will ruin the network as they may all try to digi the same signals and clog up the frequency so that no packets get through. For state wide coverage, digipeaters should be deployed every 40 miles, depending on the Height Above Average Terrain (HAAT). Portable digipeaters can be deployed into an area of poor APRS coverage to aid in temporary support of an event or disaster.

If internet is available at the digipeater site an APRS I-Gate station should be deployed. This will allow real time data from local APRS stations to be placed on the internet data base known as APRS.fi. Anyone can access the APRS.fi web server and discover the location of an APRS station.

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### **F. AREDN - Mesh networks**

AREDN (Amateur Radio Emergency Data Network) was an outgrowth of the ARRL working group on High-Speed Multimedia (HSMM). It has evolved over the past 10-12 years from its first implementation by Broadband Hamnet (BBHN).

Some refer to MESH application as Ham WiFi. Ham radio operators have taken reasonably priced commercial grade Wi-Fi access points (AP) and, by replacing the manufacturer's firmware with AREDN, have created a ham radio asset. Now, hams can implement high-speed (up to 144 Mbps) data networks in support of Emergency Operations Centers (EOCs), non-governmental agencies (NGOs) and first responders. These networks are generally confined to an operating area of a few miles depending on

terrain, the height and style of antennas and the number of nodes. The MESH concept allows the growth of the network by adding more nodes which provide a greater coverage area or a more densely covered area.

#### EmComm Applications:

Areas that have no internet or phone service are prime candidates for installation of an AREDN network and its many applications. AREDN networks can bring email, document and file sharing, VoIP phone service and many other applications to the service-deprived area. Hospitals are examples of institutions that can benefit from such networks, providing a means for doctors and administrators to coordinate medical services.

Other valuable applications for EmComm mesh networks include APRS and, especially, the remote control of radios. Ostensibly any program capable of operating peer-to-peer over TCP/IP networks could be used with this network.

#### Software:

AREDN firmware will need to be installed on the individual access points that are to be used. Firmware images for specific brands of APs can be downloaded from <https://www.arednmesh.org>. AREDN supports more than 70 devices at this time.

The AREDN software replaces the firmware in the WiFi access point turning it into an amateur radio operating on amateur radio allocations in the 2.4 Ghz, 3 Ghz and 5.8 Ghz bands. Bringing up at least two access points will establish a network. Then the introduction of additional nodes, properly configured, will assimilate into the network seamlessly and will be identified by their MAC address.

#### Hardware:

Hardware platforms must be compatible with the AREDN firmware. As mentioned above, AREDN currently supports approximately 70 devices including those manufactured by TP-LINK, Mikrotik and Ubiquiti Networks. A list of supported devices can be found at <https://www.arednmesh.org/content/supported-platform-matrix/>

Microwave frequencies are line-of-sight. Therefore, backbone configurations may require directional antennas to establish reliable links with an acceptable fade margin. It is recommended that network users not co-located with a node should use omni-directional antennas where practicable. The

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omnidirectional pattern may increase the probability of connecting to an alternate node in case of trouble.

Connections to access points may be wired or wireless; wired is often believed to be more reliable and less susceptible to interference. Wireless connectivity to access points on the amateur radio frequencies is common but may require directional antennas to overcome path loss or to null out interfering signals in some cases.

### Operational Tips:

Hardwired connections with CAT 5 or CAT 6 cable between computers and the AP are preferred. Wireless connections are possible but are vulnerable to in-band interference and may need to add a frequency conversion device to access the amateur radio portion of the band in use.

Large files, image captures and video recordings should be avoided because of possible major performance degradation on the network.

Channel planning will be required in order to establish reliable RF links. The AREDN website <https://www.arednmesh.org> provides the following frequency information (and more):

- 2.397-2.437 GHz, Channels (-) 2 thru (+) 6. All channels shared except 2.397 (Chan (-) 2) and 2.402 (Chan (-) 1). Channel 0 (zero) not available for use.
- 3.380-3.495 GHz, Channels 76-99, non-shared
- 5.665-5.895 GHz, Channels 133-179, Shared with unlicensed users, WIFI

Geographical coverage areas of 5 to 10 miles may be possible in urban terrain.

An excellent tutorial on AREDN including How-to guides is available at:

[https://arednmesh.readthedocs.io/en/stable/arednGettingStarted/aredn\\_overview.html](https://arednmesh.readthedocs.io/en/stable/arednGettingStarted/aredn_overview.html)



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## G. Pactor

Pactor is proprietary to SCS, the German company that created today's Pactor protocols and manufactures high-end Pactor modems. According to the SCS website, Pactor is one of the fastest and most accurate HF digital modes available due, in part, to its data compression techniques: <https://www1.scs-ptc.com/pactor.html>. Pactor also features 'memory' ARQ to help in the reconstruction of an original packet.

### Applications to EmComm:

Pactor brings an advanced high level protocol to the EmComm community which works very well in deteriorated band conditions. Thus, a higher expectation of successful data transfer is warranted when compared to other digital protocols on the HF bands. Moreover, the Pactor mode is fully compatible with Winlink Express.

A drop down menu in Winlink Express provides for Pactor Winlink, Pactor peer-to-peer, and Pactor Radio-only modes. Conventional text messages, ICS forms and custom forms can be transported via Pactor on the Winlink system.

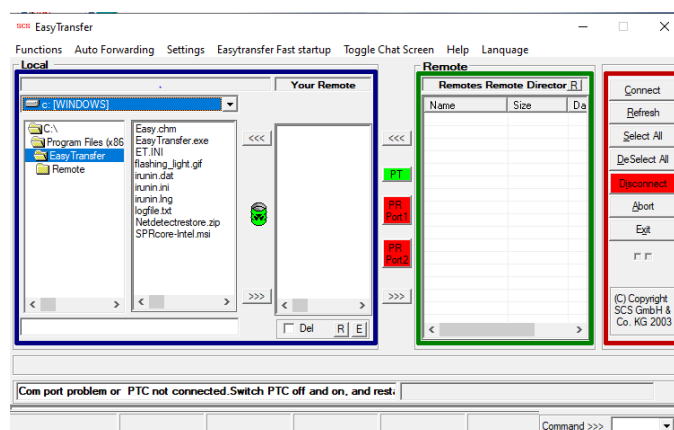
Although not Winlink compatible, the SCS *Easy Transfer* software program also transfers files, but in a different manner as explained below.

### Software:

The SCS *Easy Transfer* user interface program provides for direct communications between two Pactor stations within range of one another; in a robust radio-only peer-to-peer configuration. The internet is not used. The manner in which *Easy Transfer* transfers files between the two connected modems and computers is unique and easy, as the name implies. Each operator can drag and drop files from their

hard drives for immediate transfer to the other station. The SCS website <https://www1.scs-ptc.com/software.html> explains it this way:

"The left side of the user interface shows the content of the local hard drive, the right side shows the content of the remote directory of the distant station. Files can easily be moved between the two sides using standard drag-and-drop actions. In addition to the file transfer, EasyTransfer has a chat mode to exchange hand typed messages".



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another feature of the program, called Autoforward, provides for the unattended transfer of files. *Easy Transfer* cannot be used to connect to Winlink Express because the script will not execute correctly.

The *Easy Transfer* user interface program, manuals and firmware upgrades can be downloaded from the SCS website <https://www1.scs-ptc.com/software.html>

*Simple32 Gold Special Edition* is the program for amateur radio use with SCS Pactor modems. You must have an SCS modem to use this program. A free 'demo' version is available and is strongly recommended before purchase of the program and license at \$49.95.

### Hardware:

A computer with keyboard and mouse, an SCS Pactor modem, an HF radio and appropriate antenna are all that is needed for Pactor operation. Current SCS Pactor modems offer USB interface to computers. Cables from the Pactor modem to the radio can be ordered for a number of radio models or can be homebrewed from the schematics in the user manual. New Pactor modems cost approximately \$1250-\$2150 depending on the model.

The FCC authorizes the Pactor III protocol for use on the US amateur bands. Pactor level III upgrades are available for current PTC modems with a software upgrade. The Pactor IV protocol is not authorized for use on U.S. amateur bands as of this writing and is primarily used by federal, state and local agencies on governmental frequencies. The Pactor IV modems have built-in fallback when detecting the earlier Pactor I-II-III protocols and can thus be used on the amateur bands. Pactor I and II are not considered suitable for serious use today due primarily to comparatively slow speeds.

The SCS DR-7800 Pactor IV modem equipped with the optional Ethernet card can be configured for use on local or remote LANs. The LAN option can be a "plus" for multi-operator stations and remote-control operations. The #2365 Ethernet/Linux Ethernet 'network' option for the DR-7800 is sold separately for approximately \$225.

### Operational tips:

An example of a remote control configuration is that used by the Missouri State Emergency Management Agency (SEMA). SEMA operates their DR-7800 Pactor IV modem/ Winlink Express remotely via LAN at their tower site with a DSL link. A Virtual Serial Port is used to steer Winlink Express to the Pactor modem. This configuration demonstrates how amateur radio operators can set up their own remote control networks.

As mentioned earlier, legacy Pactor I and II protocols are seldom used today due to the slower speeds involved. Pactor II provides a maximum of 1200 Bits/sec. Pactor III runs at 5200 Bits/sec. Pactor IV modems offer transfer rates of 1.5 to 3.5 times faster than Pactor III. Focusing on amateur radio, comparisons between Pactor III and the VARA sound card mode were conducted by Anthony Bombardiere, K2MO on the 40 and 80 meter bands. The tests indicated that VARA could produce greater transfer speeds than Pactor III under ideal band conditions. However, Pactor III eventually became faster under deteriorating band conditions. The tests were conducted using a Winlink session. This comparison was posted by K2MO on May 27, 2018 at: [https://digitalradio.groups.io/g/main/topic/vara\\_vs\\_pactor\\_iii\\_speed/20347199?p=,,,20,0,0,0::recentpostdate%2Fsticky,,,20,2,0,20347199](https://digitalradio.groups.io/g/main/topic/vara_vs_pactor_iii_speed/20347199?p=,,,20,0,0,0::recentpostdate%2Fsticky,,,20,2,0,20347199)

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### H. BPQ32

BPQ32 is a versatile suite of programs for radio networking. It runs under Microsoft Windows as BPQ32 or as LinBPQ under Linux. It allows a computer to act as a node in an AX.25 NET/ROM network, with serial interfaces to TNC's supporting KISS, JKISS, multi-drop BPQKISS and NET/ROM interfaces. It also supports internet connections via AX/IP/UDP as well as interfacing with AGWPE via a BPQtoAGW DLL. This latter capability allows BPQ32 to provide AX.25 NET/ROM services via devices connected to AGWPE, most significantly sound card modems. It also supports data-over-radio protocols other than AX.25 packet, including a driver for the WINMOR Virtual TNC, Pactor, V4, Telnet and others. The program can be configured many ways for many applications, including as an RMS gateway in the Winlink system, or as a client for communicating with RMS gateways, and more.

\*<https://www.winlink.org/BPQ32>

#### Application To EmComm

BPQ32 supports RMS, CMS, Packet and a variety of other digital protocols and can therefore operate on VHF, UHF and HF. The BBS/Node and multi-user, multi-mode features provide capability for rapid through-put of emergency message traffic. Currently there are only four BPQ32 Nodes in Missouri located in ARES Districts H (one node) and C (three nodes).

#### Software

BPQ32 software is available for either a Windows or Linux environment. The Linux version is finding popularity among Raspberry Pi computer users, for low-cost, low-power implementations. BPQ32 is a product of John Wiseman G8BPQ/GM8BPQ. BPQ32 or LinBPQ are not in the public domain. However,

they may be freely used by licensed radio amateurs in amateur radio applications. Software releases are available in the files section of the [BPQ32 Yahoo Group](#), or [www.cantab.net/users/john.wiseman/Documents/index.html](http://www.cantab.net/users/john.wiseman/Documents/index.html)

The main AX.25 interface to radios is via KISS mode TNCs connected to standard RS232 com ports. Other AX.25 interfaces provided are shown below:

#### AX25 Interfaces

BPQtoAGW  
BPQAXIP  
BPQETHER  
BPQVKISS  
SCS Tracker  
UZ7HO Sound Modem

#### Non-AX25 Radio Interfaces.

AEAPactor  
ARDOP  
FLDigi  
HALDriver  
KAM Pactor  
MultiPSK  
SCS Pactor  
Serial TNC  
Telnet  
V4  
VARA  
Winmor

The software includes an APRS compatible Digipeater and an interface to APRS/IS. A Mapping and Messaging application is available for use in conjunction with these interfaces. A Rig Control Driver, is also included.

\* [www.cantab.net/users/john.wiseman/Documents/BPQ32.html](http://www.cantab.net/users/john.wiseman/Documents/BPQ32.html)

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### Hardware

BPQ32 requires only a computer running under Microsoft Windows® or Linux to act as a Node in a NET/ROM compatible AX25 network, and to support a multiuser Mailbox, or other similar applications. The switch section of the code allows up to 32 comms ports, supporting a number of radio protocols and the application interface supports up to 64 connections.

*\*[www.cantab.net/users/john.wiseman/Documents/BPQ32.html](http://www.cantab.net/users/john.wiseman/Documents/BPQ32.html)*

### Operational Tips

Configuration of the BPQ32 server software is generally not recommended for the casual radio email user. However, there are numerous websites and user groups dedicated to assisting new System Operators. Several offer free configuration files, which are easily modified, to help with setting up the BPQ32 software and its various components. Most radio email clients (Hams) connect to the BPQ32 servers with Winlink Express using the same software settings they use for the Winlink.org system.

It has been suggested that a statewide BPQ32 network could be established to become a pseudo-private platform for Missouri DECs and/or ECs to communicate (thereby establishing a statewide interoperability path). For example, if one BPQ32 station were installed in each district it would create the foundation of a interoperative digital network that would serve the county, district and statewide ARES EmComm requirements.

Assistance in using BPQ32 can be found at these websites and others:

[www.cantab.net/users/john.wiseman/Documents/BPQ32.html](http://www.cantab.net/users/john.wiseman/Documents/BPQ32.html)

[www https://nts-digital.net/mw/index.php/BPQ32\\_Hub\\_Operators](https://nts-digital.net/mw/index.php/BPQ32_Hub_Operators)

[www https://packet-radio.net/bpq32/](https://packet-radio.net/bpq32/)

[www https://www.wh6fqe.com/bpq32-config](https://www.wh6fqe.com/bpq32-config)

[www www.cantab.net/users/john.wiseman/Documents/Using%20WINMOR.htm](http://www.cantab.net/users/john.wiseman/Documents/Using%20WINMOR.htm)

Note: URL's in italic preceded by an asterisk (\*) indicate the material cited above them was copied, derived or adapted from that website.

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### I. JS8Call

JS8Call is a weak-signal mode with keyboard-to-keyboard messaging, store-and-forward messaging, and automatic station announcements. The JS8Call program uses a sound-card interface; making it an immediate hardware transition for stations already running sound-card based digital programs such as Fldigi, Digipan and others.

The features offered by JS8Call can be applied to a variety of scenarios facing ARES responders.

#### Specific applications to Emcomm

JS8Call would be a good alternative for net control and coordination across a wide area, then moving formal traffic off frequency. This mode has the ability to forward messages to stations which are difficult to reach directly, to store messages at an unattended destination station, and to store third-party messages at intermediate stations. The "network" of JS8Call stations can be queried for the presence of stations, and for the presence of messages stored for a querying station.

Because JS8Call operates over the whole of the audio passband at a selected radio dial frequency it is possible for multiple simultaneous conversations to occur at the same dial frequency. This can be used to the advantage of a net control station to query the network (e.g., by sending a "Heartbeat" signal) and all stations in the audio passband who are enabled for automatic operation and in the passband will respond simultaneously on different frequencies, thus generating an instantaneous net station list. In addition, multiple traffic messages, if sent via JS8Call in the passband, can be monitored by Net Control. This multiple-frequency simultaneous operation is a significant advantage over other similar modes such as FSQCall, which is limited to a single frequency of 1500 Hz in the passband.

#### Software:

The software is called "JS8Call," is free and is available for all prominent operating-systems (Microsoft Windows, Linux, and MacOS). The source code is freely-available open-source. JS8Call is available at <http://js8call.com>.

#### Hardware:

Any computer-radio interfaced system for running any of the generally-accepted data modes, such as PSK31, in Upper Side Band can be used to run JS8Call. Hence the minimum requirements are for audio interfacing between the computer and the radio, and provision for Push-To-Talk (PTT) functionality between the computer and the radio (e.g., Signalink, RIGblaster, RigExpert, home-brew interfacing, and on some modern radios the built-in data-mode interfacing). The software can take advantage of computer Assisted Tuning (CAT) if available, but CAT interfacing is not required.

#### Operational tips:

For best performance, be sure (as with all Audio Frequency-Shift-Keying [AFSK] data modes) that the audio drive to the radio does not "overdrive" the radio audio chain, thus preventing the generation of spurious sidebands. A good rule-of-thumb here is to set the radio internal menu to 100% output power, then gradually increase the audio drive from the computer to the radio until no more than 25% of maximum output power is achieved (e.g., increase the audio drive from JS8Call until a 100-Watt radio transmits less than 25 Watts).

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### Communications Interoperability

During times of crisis it is important that served agencies have the ability to contact one another efficiently and as quickly as possible. A certain amount of pre-planning, implementation of the plan(s), and the commitment of individuals and agencies are required in order to achieve this goal. The focus of this section will be upon establishing a template outlining the known and probable paths through which EmComm interoperability may be achieved locally, regionally, statewide and beyond.

Interoperability is all about planning, organization, training and exercises or drills. The goal of interoperability is to establish common paths through which disparate local agencies can quickly set up channels of communications with responders and supporting agencies within and outside the impact zone.

Many amateurs already possess the hardware and software needed for expanded interoperability. Stations equipped with HF/VHF/UHF radios, antennas and various digital data software programs can serve as bridges or hubs to other agencies or responders. Agreements between agencies, NGOs and other ARES responder groups greatly facilitate this process and ICS-217 and ICS-205 forms posted at the respective venues provide ready references for operators. Official Emergency Stations (OES), properly equipped, might be ideal for this assignment. Official Emergency Stations will be discussed later in this document..

#### Recommendations for baseline interoperability:

- Identify mission partner agencies, NGOs and groups with whom to expect a need to communicate.
- Consummate written Memorandum Of Understanding (MOU) agreements with these partner agencies, NGOs and other ARES response groups.
- Strive to maintain proficiency by training and practicing the provisions of those agreements using the prescribed nets and radios. Be sure to include home-based operators acting as multi-mode hubs or relay stations
- Develop so-called 'storm plans' and include such plans in MOUs or other agreements. Storm plans are essentially a hierarchal method of fallback from a preferred method or protocol of operation when that method is no longer viable. Consider using the acronym P.A.C.E; Primary-Alternate-Contingency-Emergency to develop a storm plan. The following example outlines a possible PACE configuration:
  - P – Direct packet connection to recipient station
  - A – Digipeter connection if/when direct connection fails
  - C – Area packet operator enables his/her TNC for digipeter operation or as PBBS to help overcome communication failures
  - E – Peer-to-peer packet station relays until destination reached

*Note: This PACE model should be pre-arranged and practiced by participating stations and agencies*

The preparation of 'go' kits should be a priority; kits that can be deployed most anywhere on short notice. The 'go' kits should also include off-grid power for initial, temporary operation.

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#### Official Emergency Station (digital)

- Each ARES® district in Missouri should have at least one primary and one secondary Official Emergency Station (OES) with digital capability. Ideally one per county.
- OES stations should be geographically separated, but located where they are usable throughout the area.
- OES stations should ideally be equipped for HF and VHF/UHF digital operations and have backup power available during an extended power failure.

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## Digital Data Communications Resource Guide 2020

### Digital Data Networks

Digital Data Nets stood up in response to an incident or disaster should be managed much like the more familiar voice nets in order to be efficient and effective. Net control stations (NCS) should be assigned according to pre-established plans but, customarily, the first operator to arrive on frequency is the de facto NCS until the assigned operator arrives or other arrangements are made in the interim. If more than one net is activated it may be necessary to bring in net managers to ensure a smooth flow of traffic within and between nets.

The following list of nets and frequencies should be considered for inclusion in the development of local, regional and state level response plans. ICS Forms 205 and 309 should be filled out and posted at each station.

#### A. National Traffic System (NTS/NTSD) and Radio Relay International (RRI)

NTS - The ARRL NTS is a national system for conveying formal, written messages (Radiogram format) from origin to destination. NTS nets operate at four functional levels; local net(s), section net(s), region net(s) and area net(s). Messaging between area nets is a function of the Transcontinental Corps. Messages traverse up and down this hierarchy based upon their origin and destination.

NTSD – NTS Digital traffic nets support the legacy voice/CW NTS nets but can operate independently as well. Digital traffic is handled by a group of NTS-approved Digital Relay Stations using mailbox store and forward techniques. Traffic routing may include HF long haul and local VHF/UHF nodes using a variety of digital modes and best path choices. The standard ARRL Radiogram format is used for all messages; a potentially serious drawback for other than routine 'birthday' or health/welfare types of short messages.

NTSD and Radio Relay International (RRI)/Digital Traffic Network (DTN) – The RRI organization and its operators are closely aligned with NTSD at the 'region' and 'area' levels; a symbiotic relationship in many ways. RRI members use the NTSD infrastructure and the NTS hierarchy as its messaging platform. Sound card modes, Packet, and Pactor are used by RRI to connect to its hubs. RRI operators use Airmail, Winlink Express and BPQ32 to facilitate message handling. RRI operators have the option of conveying ICS forms, a definite advantage for EmComm purposes. A list of DTN stations can be found at [http://nts-digital.net/mw/index.php/DTN\\_Stations](http://nts-digital.net/mw/index.php/DTN_Stations) The Missouri list needs updating as of this writing.

*Note: The use of unattended mailboxes and unscheduled or infrequent nets may delay or halt delivery of messages.*

#### B. HF statewide digital data net(s):

The Missouri Digital Emergency Services (MODES) net (formerly FSQCall digital data net) is activated Thursday each week at 1000 hours local time. This is a directed net with text messaging visible to all persons using this mode on frequency. This net provides local, regional, intrastate and interstate point to point HF digital NBEMS communications to served agencies. Primary locations include city and county emergency operations centers.

FSQCall and fldigi/flmsg/flamp can run concurrently on the same frequency. FSQ station-to-station keyboard chat is assigned to **1500Hz** on the waterfall. Flmsg NBEMS traffic and Flamp traffic is assigned to **700Hz** on the waterfall.



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Unattended stations monitor the MODES net on FSQCall 24 hours/day.

For more information: [P2P+subscribe@MODES.groups.io](mailto:P2P+subscribe@MODES.groups.io)

### MODES HF Operating Dial Frequencies

Primary 0000 to 2400 Hrs	3598 usb	Unattended & Attended
Secondary (daytime)	7099 usb	Unattended & Attended
Primary 0000 to 2400 Hrs	3563 usb +/- 1Khz	Attended Operation Only
Secondary (daytime)	7063 usb +/- 1Khz	Attended Operation Only

### NBEMS Traffic Modes

* Preferred	Conditions
PSKR 250 or 125	Very Good
8PSK 250 or 125	Very Good
*Thor22 or MFSK32	Good
*Thor 16 ,11 or MFSK16	Average
*Thor8	Poor

### C. Statewide VHF/UHF Digital Data Simplex Frequencies

Simplex frequencies are valuable resources and particularly useful for on-scene activities, for direct contact with and between command centers, and shelter-to-shelter types of operation. There are many other applications for simplex frequencies and it's helpful to have the following, and additional, frequencies pre-programmed into the radios of first responders.

HMDData	52.790	Wide area inter-district networks
HVData	144.910	Intra-district networks
HVTac0	147.495	Local links
HUDData	446.200	On-scene

### D. Local VHF/UHF/Microwave digital data nets

VHF/UHF Packet would be a logical choice for local digital data nets. It should be a priority to install or pre-deploy multi-mode TNC's and radio equipment at the city and county EOC's and other key public safety and disaster relief organizations such as hospitals and Red Cross facilities.

During activation, packet users that are not involved in the incident should refrain from using the primary frequency, 145.070 MHz, or whatever the primary frequency is for the affected area. Similarly, stations are expected to halt all traffic that is not related to the ARES® operation.

As mentioned earlier, the preparation of 'go' kits should be a priority; Packet and digipeater kits that can be deployed most anywhere on short notice. The 'go' kits should also include off-grid power for initial, temporary operation.

Microwave nets: Point-to-point systems and mesh networking systems in the 2.4, 3, and 5 GHz ranges would likely be the most useful for EmComm purposes. Mesh networks would provide the most potential for multi-user access. An example of a viable microwave local network is the Kansas City mesh network that provides data and VOIP connectivity among hospitals in the metro area.

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The following internet-listed microwave groups provide information regarding their activities and links to additional sites:

St. Louis Area Microwave Society (SLAMS) <https://slams-stlouis.blogspot.com/>

Kansas City Mesh (KCmesh): [KCmesh@groupsi.org](mailto:KCmesh@groupsi.org)

North Texas Microwave Society (NTMS) <http://ntms.org/content.php>

### E. HF Out-of-state digital data nets:

Out of state digital data nets should be considered as tools in the interoperability toolbox. It may be advantageous to enlist the assistance of these nets in reaching beyond the Missouri Section. Digital nets to be considered might include the following:

- Indiana Digital Traffic Net (IDTN), 3.585 MHz, Olivia 8/500, Monday-Friday, 0900 Eastern <https://www.inarrl.org/index.php/public-service/indiana-nts>
- Indiana ARES Digital Net (IDN), 3.583 MHz, Olivia 8/500, Wednesday, 2030 Eastern <http://www.hoosierlakesradioclub.org/indiana-traffic-nets/>
- Iowa ARES Digital Net (IDN), 3.5725 MHz, Olivia 8/500, Tuesday, 1900 Central <https://w0gq.org/iowa-section-nets/>
- Kentucky Digital Modes Net (KDN)– 3.585 MHz, PSK31, Wednesday, 2030 Eastern <http://www.w4cn.org/about-ham-radio/national-traffic-nts>
- Kentucky Digital Modes Net 2 (KDN-2)– 3.585 MHz, PSK31, Monday, 2030 Eastern <http://www.w4cn.org/about-ham-radio/national-traffic-nts>
- Michigan Digital Net (MIDTN) 3.583 MHz, Olivia 8/500, 1000 Hz waterfall, Tuesday-Thursday-Saturday, 1900 Eastern <http://wa8lmf.net/miscinfo/MI-Digital-Traffic-Net-Info.pdf>
- ORCA Digital Net, 3.581 MHz, MFSK32, Tuesday 1930 Pacific/0230 Zulu <http://orcadigitalnet.com/>

### F. Amateur Radio – Governmental Interoperability

An agreement between the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC) enables both amateurs and the federal government to communicate with one another on one or more of the five 60 meter frequencies.

SHARES –The SHARED RESources HF radio program is a component of the U.S. Department of Homeland Security (DHS), National Communications & Coordination Branch (NCC). SHARES allows direct communications support to federal, state and local governmental agencies, critical infrastructure, and key resources (CI/KR) facilities in many forms. The regional and national HF radio coordination nets provide an interoperability platform available to SHARES member agencies CI/KR facilities and institutions. The Missouri State Emergency Management Agency (SEMA), Boone County Office of Emergency Management/Joint Communications Center, Caldwell County Emergency Management, Livingston County Emergency Management and Webster County Emergency Management are among authorized SHARES partners in Missouri. Not all SHARES stations are equipped for SHARES Winlink operation or digital operations in general but do have voice capability on the SHARES networks.

ARES members and registered MARS members, working on behalf of their served agencies, have access to the vast membership and network of the SHARES program. Moreover, SHARES uses a number of digital data modes that are common in the amateur radio world. MT-63 1000L, other modes in the Fldigi suite and CW are in common use on SHARES nets. SHARES-only Winlink RMS Gateway stations using SCS Pactor 4 modems have been established around the U.S. and one of those is located at the Livingston County Emergency Management facility in Chillicothe, Missouri. More SHARES Winlink RMS

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facilities are being planned in Missouri. This means that amateurs accustomed to using these modes already know how to use them in the SHARES environment.

### Networking Tips

1) The ARRL recommends specific types of networks based upon the EmComm mission. Some, or all, of these nets may be needed depending upon the situation.

Administrative net – NCS and Incident Command representative are here.

- Traffic net – written messages between agencies or other nets
- Resource net – operator check-ins for assignment, locate equipment
- Tactical net – on-site operations
- Information net – announcements, bulletins
- Health and Welfare net – self-explanatory, usually handled by NGOs such as the American Red Cross (ARC).

2) Consider contacting voice nets to recruit additional digital operators for temporary or long term assignments. Consider assigning ARRL Official Emergency Stations (OES) this task or as liaison between nets, for inter-district communications, or to search for regional or national nets to engage for additional communications paths or relays.

3) More than one person at each station will likely be needed to handle logging, draft messages, coordination of message priority levels, deal with agency staff, and miscellaneous tasks.

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### Missouri Section Ares Recommendations

A. Establish a Missouri Section ARES HF digital data net

The net shall be established for the purpose of responding to local, regional and statewide emergencies. The existing MESN voice net and the proposed Missouri Section ARES HF digital data net may be called upon to respond to the incident. A proposed activation procedure is covered in Appendix A.

The Missouri Section ARES HF digital data net will be established on frequencies and modes as shown in Appendix A.

B. Develop Local, District and Section response plans for use throughout the state, including ICS-217 forms to be posted on the Missouri Section ARES website. VHF/UHF plans for a number of Missouri counties are currently listed on ICS-217 forms at <https://ares-mo.org/forms/ics-217-forms> ARES members are encouraged to add their county assets to this list. HF frequencies should be included as well. See Appendix A for examples of Missouri Section ARES District ICS-217 forms.

\*A separate ICS-217 form listing the HF digital data net frequencies of all ARES districts should be compiled and posted on the Missouri Section ARES website.

Please refer to the SEMA Contact Sheet for inclusion in frequency plans: <https://ares-mo.org/forms/sema-resource-form/>

Just as importantly, meeting the needs of served agencies should be the focus of any response plans regardless of geographical area. Plans should include more than just a frequency plan. For examples of topics to include in response plans please see Appendix B.

C. Establish statewide drills or exercises to be held at a minimum of every 90 days, preferably more frequently, to practice and validate statewide response plans and procedures. It is therefore recommended that the SEC or the SEC's designee develop a standard protocol for exercising the emergency nets, including requirements that

- the MESN voice net be stood up concurrently with the digital net and integrated into the overall net strategy so as to practice and streamline joint operations
- a training syllabus be developed identifying skills to be addressed and practiced during each net session
- standardized message formats and handling procedures be clearly defined
- each participant in the digital and voice nets send and receive at least one message
- injects be developed to cause concurrent interactive messaging between the digital and voice nets.
- the Missouri Section ARES DMR talk group be incorporated into drills and exercises to provide a communications path for coordination and control.

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### D. Documentation and Record Retention

There is a saying that goes, “If it’s not on paper; it didn’t happen.” Typical of forms required by governmental served agencies are the ICS-205 Incident Radio Communications Plan, ICS-213 General Message Form, ICS-214 Activity Log and an ICS-309 Communications Log. These documents become a part of the official record of a government agency or an NGO’s involvement in an incident or disaster. ARES members may be required to submit these and other forms for archiving.

Fortunately, Winlink Express, Fldigi/Fldmsg and other digital programs have built-in NBEMS forms, automatic logging or both. These records can be printed out and submitted to the served agency. ARES members associated with an EOC should consider using the Missouri Section ARES WebEOC Ham Radio Resource Request Form. This form can be loaded into Fldigi NBEMS custom files. The form and instructions are available at <https://ares-mo.org/forms/sema-resource-form/>

Fillable ICS forms are available at <https://ares-mo.org/forms/ics-forms/>

- E. Every district develops a digital go-kit for district use. The go kit should contain operator-supplied computer/printer with sound card, TNC, 13.8V power supply, batteries or solar, HF/VHF/UHF antennas, antenna tuner, suggest 80M-40M NVIS dipole on a 15' PVC pipe mast and a tool box, cables and connectors for installation and repair. *Note: Other configurations of multiband HF antennas elevated 15-30 feet above ground also tend to exhibit NVIS characteristics that substantially cover the state.*
- F. Establish APRS monitoring at EOCs and command posts as a means of tracking the position of supporting mobile and portable amateur radio operators.
- G. Establish Winlink RMS nodes in each district to improve access and interoperability.
- H. Establish a series of BPQ32 Bulletin Board Systems (BBS) in Missouri as repositories for statewide ARES related tactical response information or general message traffic. The BPQ32 system utilizes the Winlink Express software and NBEMS forms on non-Winlink frequencies, bypassing the Winlink Express system entirely. One example of an application would be the one-to-many broadcast feature to notify, say all ARES DEC's, that a disaster had occurred somewhere in the state, asking for additional ARES volunteers to respond to an official staging area. The one-to-many feature is conceptually similar to Winlink Express 'group' addresses.

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### ICS-217 Appendix Models

The Radio Frequency Assignment Worksheet (ICS-217) forms provided in this appendix are intended to be used as a starting point for preparation of detailed communications plans. They contain the basic established district and statewide frequencies and modes documented elsewhere. If plans are not otherwise established each EC should refer to the appropriate form for his district to begin building a communications plan. It should be kept in mind that some communications resources (i.e. repeaters, etc.) may be located outside a district but still be viable. When designating district digital calling and working frequencies 5KHz spacing from other established frequencies should be observed to avoid interference. *Disclaimer: The frequency plans in Appendix B are presented as models. Existing or future District plans may be substantially different.*

For planning purposes, frequencies commonly used for various digital modes should be avoided. These would include Winlink (from your drop down menu) and the following center frequencies for the WU0G-1 North Missouri Private Mail Server: 3.582, 7.086 and 14.0855 MHz.

A list of commonly used digital mode frequencies can be found at websites hosting that particular mode, such as <https://bpsk31.com/operation/>.

### **Appendices:**

- A. Statewide HF Digital Data Net
- B. ICS-217 – Radio Frequency Assignment Worksheet – Model forms for each ARES District
- C. Sample Outline for Local and District Plans
- D. Sample Outline for Go Kits

# Missouri Section ARES®

## Digital Data Communications Resource Guide 2020

### Appendix A – Missouri Section ARES Statewide HF Digital Data Net

The purpose of the HF Digital Data Network is to provide a mechanism through which lengthy and detailed messages, including various ICS and agency-specific forms, can be efficiently passed within a region, across the state and beyond. The net is meant to supplement or to extend digital data communications beyond the boundaries covered by local digital data nets. This HF digital data net is intended to work in close partnership with the Missouri Emergency Services Net (voice). The following information describes the fundamental structure and basic operation of the proposed net.

**Activation:** The evolution and expansion of the incident from the local level will determine the sequence and the scale of response from the MESN and the Missouri Section ARES Digital Data Net. The on-site ARES responder(s) will evaluate the communication needs to determine which communications assets will best meet the immediate or anticipated net requirements. If deemed necessary, the Net Manager may be requested to activate the MESN and the HF Digital Data Network. These assets may be activated independently or jointly by the ARES Net Manager, or in the absence of a Net Manager, by the point of contact (POC) of the individual nets.

#### Digital Data Frequencies and Modes

Statewide HF frequencies for initial response and message handling are provided in the table below.

**Statewide Primary Call (Rally) Frequencies**

Assignment	Frequency	Mode	Waterfall
Primary Call	3.590 USB	*BPSK-31	1500
Secondary Call	7.083 USB	*BPSK-31	1500
Alternate Call	5.3465 USB	*BPSK-31	1500
Working/Messaging	NCS Directed	**TBD by Band cndx	700
***MESN Voice Net	3.963 LSB	A3	N/A

\* BPSK-31 shall be the initial mode employed to assemble the net. However, NCS shall have the discretion to temporarily change the frequency, mode and waterfall as deemed immediately necessary. BPSK-31 is chosen due to its universal availability and history as a common operating platform among radio amateurs.

\*\* Band conditions will, in large measure, determine the best 'mode' of operation (including decisions whether to use ARQ) - - See NBEMS Messaging Modes chart below:

**NBEMS Messaging Modes**

* Preferred	Conditions
PSKR 250 or 125	Very Good
8PSK 250 or 125	Very Good
*Thor22 or MFSK32	Good
*Thor 16 ,11 or MFSK16	Average
*Thor8	Poor

\*\*\*It is intended that the statewide, district and local digital nets work together and pool resources with the Missouri Emergency Services Net (voice) to provide first mile (origin) or last mile (destination) connectivity as may be required to complete the route.

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## Digital Data Communications Resource Guide 2020

### Basic Procedures :

- All operation is based on the Fldigi suite of programs downloadable at <http://www.w1hki.com/download.html>.
- FLmsg will be used for formal traffic handling. Flamp may also be used as appropriate. The Fldigi section in the Digital Data Modes, Hardware and Software section may be consulted for detailed information regarding the use of messaging modes. The NBEMS messaging modes table above should be consulted for best practices under various band conditions.
- The net may be convened with or without a Net Control Station as dictated by the intended use and the number of participants.
- Message traffic to be conducted on a frequency far enough removed from the net so as not to cause interference.

### Initial Check-ins:

- Called on the Primary Frequency of 3.590 MHz, USB, BPSK31, 1500 Hz waterfall. After the net is established, the NCS may designate an alternate mode from the Fldigi suite as deemed necessary.
- If no check-ins after 10 minutes, the net will be called again on the secondary frequency (7.083 MHz USB) and the alternate frequency (5.3465 MHz USB) as desired. The net will then return to the primary frequency and the cycle begins again.
- Once the net is established, a general call for emergency or priority traffic should be made so as not to delay this material.
- Take check-ins and traffic from stations performing liaison for served agencies or other traffic nets first.
- If the net is to remain in session with periods of inactivity, announce the net every 10 minutes or so to ensure people do not forget the net is active.

### Record keeping:

- Log all contacts
- Document and archive all messages, including pertinent notes.

### Operational Tips:

- A minimum of two operators at each station; one to operate, one to take notes and fill out log
- Set fldigi program audio drive level to have an output power no more than 20 watts for a 100 watt capable transceiver.
- Develop a set of Fldigi macros to increase efficiency of standard transmissions such as log-ins











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Appendix B – ICS-217  
District E Model

COMMUNICATIONS RESOURCE AVAILABILITY WORKSHEET										
Frequency Band										
Description										
ARES District E										
Channel Configuration	Channel Name/Trunked Radio System/Talkgroup	Eligible Users	RX Freq	NotW	RX Tone/NAC	TX Freq	NotW	TX Tone/NAC	Mode A, D or M	Remarks
Calling	HF Digital	NCS	3.590	USB	N/A	3.590	USB	N/A	D	Statewide HF Calling
Calling	HF Digital Alt	NCS	7.083	USB	N/A	7.083	USB	N/A	D	Statewide HF Calling Alt
Calling	HF Digital Alt	NCS	5.3465	USB	N/A	5.3465	USB	N/A	D	Statewide HF Calling Alt
Working	HF Digital	Digital Net	NCS	Direction	N/A	NCS	Direction	N/A	D	Statewide HF Working
Calling	HF Digital	NCS	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Calling
Calling	HF Digital	Digital Net	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Working
Calling	HVCall		146.550	CSQ	CSQ	146.550	CSQ	CSQ	A	Statewide VHF Calling
Data	HVData		144.910	CSQ	CSQ	144.910	CSQ	CSQ	D	Statewide Data
Packet	HVPacket		144.950	CSQ	CSQ	144.950	CSQ	CSQ	D	Statewide Packet
Tactical	HVTac5	District E	146.445	PL 100.0	PL 100.0	146.445	PL 100.0	PL 100.0	A	District E VHF Tactical
Calling	HUCall		446.000	CSQ	CSQ	446.000	CSQ	CSQ	A	Statewide UHF Calling
Data	HUData		446.200	CSQ	CSQ	446.200	CSQ	CSQ	D	Statewide Data
Calling	HUTac5	District E	446.025	PL 100.0	PL 100.0	446.025	PL 100.0	PL 100.0	A	District E UHF Tactical
Msg Trfc	MESN Pri	HF :LSB Net	3.963	N/A	N/A	3.963	N/A	N/A	A	MESN
Msg Trfc	MESN Sec	HF :LSB Net	7.263	N/A	N/A	7.263	N/A	N/A	A	MESN

The convention calls for frequency lists to show four digits after the decimal place, followed by either an "N" or a "W", depending on whether the frequency is narrow or wide band. Mode refers to either "A" or "D" indicating analog or digital (e.g. Project 25) or "M" indicating mixed mode. All channels are shown as if programmed in a control station, mobile or portable radio. Repeater and base stations must be programmed with the Rx and Tx reversed.

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Appendix B – ICS-217  
District F Model

<b>COMMUNICATIONS RESOURCE AVAILABILITY WORKSHEET</b>										
Channel Configuration	Channel Name/Trunked Radio System/Talkgroup	Eligible Users	RX Freq	Nor/W	RX Tone/NAC	TX Freq	Nor/W	TX Tone/NAC	Mode A, D or M	Description
										ARES District F
Calling	HF Digital	NCS	3.590	USB	N/A	3.590	USB	N/A	D	Statewide HF Calling
Calling	HF Digital Alt	NCS	7.083	USB	N/A	7.083	USB	N/A	D	Statewide HF Calling Alt
Calling	HF Digital Alt	NCS	5.3465	USB	N/A	5.3465	USB	N/A	D	Statewide HF Calling Alt
Working	HF Digital	Digital Net	NCS	Direction	N/A	NCS	Direction	N/A	D	Statewide HF Working
Calling	HF Digital	NCS	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Calling
Calling	HF Digital	Digital Net	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Working
Calling	HVCall		146.550		CSQ	146.550		CSQ	A	Statewide VHF Calling
Data	HVData		144.910		CSQ	144.910		CSQ	D	Statewide Data
Data	HVPacket	Packet	145.070		CSQ	145.070		CSQ	D	MJEF digipeater & Winlink
Packet	HVPacket		144.950		CSQ	144.950		CSQ	D	Statewide Packet
Tactical	HVTac6	District F	146.505		PL 100.0	146.505		PL 100.0	A	District F VHF Tactical
Calling	HUCall		446.000		CSQ	446.000		CSQ	A	Statewide UHF Calling
Data	HUData		446.200		CSQ	446.200		CSQ	D	Statewide Data
Calling	HUTac6	District F	446.075		PL 100.0	446.075		PL 100.0	A	District F UHF Tactical
Msg Trfc	MESN Pri	HF :LSB Net	3.963		N/A	3.963		N/A	A	MESN
Msg Trfc	MESN Sec	HF :LSB Net	7.263		N/A	7.263		N/A	A	MESN

The convention calls for frequency lists to show four digits after the decimal place, followed by either an "N" or a "W", depending on whether the frequency is narrow or wide band. Mode refers to either "A" or "D" indicating analog or digital (e.g. Project 25) or "M" indicating mixed mode. All channels are shown as if programmed in a control station, mobile or portable radio. Repeater and base stations must be programmed with the Rx and Tx reversed.







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Appendix B – ICS-217  
District I Model

<b>COMMUNICATIONS RESOURCE AVAILABILITY WORKSHEET</b>										
Channel Configuration	Channel Name/Trunked Radio System Talkgroup	Eligible Users	RX Freq	NorW	RX Tone/NAC	TX Freq	NorW	TX Tone/NAC	Mode A, D, or M	Description
										ARES District I
Calling	HF Digital	NCS	3.590	USB	N/A	3.590	USB	N/A	D	Statewide HF Calling
Calling	HF Digital Alt	NCS	7.083	USB	N/A	7.083	USB	N/A	D	Statewide HF Calling Alt
Calling	HF Digital Alt	NCS	5.3465	USB	N/A	5.3465	USB	N/A	D	Statewide HF Calling Alt
Working	HF Digital	Digital Net	NCS	Direction	N/A	NCS	Direction	N/A	D	Statewide HF Working
Calling	HF Digital	NCS	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Calling
Calling	HF Digital	Digital Net	3.5XX	USB	N/A	3.5XX	USB	N/A	D	District HF Working
Calling	HVCall		146.550		CSQ	146.550		CSQ	A	Statewide VHF Calling
Data	HVData		144.910		CSQ	144.910		CSQ	D	Statewide Data
Packet	HVPacket		144.950		CSQ	144.950		CSQ	D	Statewide Packet
Tactical	HVTac9	District I	147.450		PL 100.0	147.450		PL 100.0	A	District I VHF Tactical
Calling	HUCall		446.000		CSQ	446.000		CSQ	A	Statewide UHF Calling
Data	HUData		446.200		CSQ	446.200		CSQ	D	Statewide Data
Calling	HUTac9	District I	446.125		PL 100.0	446.125		PL 100.0	A	District I UHF Tactical
Msg Trfc	MESN Pri	HF :LSB Net	3.963		N/A	3.963		N/A	A	MESN
Msg Trfc	MESN Sec	HF :LSB Net	7.263		N/A	7.263		N/A	A	MESN

The convention calls for frequency lists to show four digits after the decimal place, followed by either an "N" or a "W", depending on whether the frequency is narrow or wide band. Mode refers to either "A" or "D" indicating analog or digital (e.g. Project 25) or "M" indicating mixed mode. All channels are shown as if programmed in a control station, mobile or portable radio. Repeater and base stations must be programmed with the Rx and Tx reversed.

# Missouri Section ARES®

## Digital Data Communications Resource Guide 2020

### Appendix C - Sample Outline for Local and District Plans

Digital modes in everyday use by amateur radio operators do not require the structure of a network. They largely operate as any of the other modes available to amateurs seeking to make new contacts. However, EmComm applications require forethought in the development of plans to establish effective communication to and from a local area impacted by a disaster or emergency. This section will examine those things which should be considered in planning for such an event:

#### Local ARES

- ❖ On Scene Communications
  - NCS for voice and digital
  - Establish modes & frequencies
  - Portable digipeaters
- ❖ Served Agency Communications
  - Establish Relationships
    - EOC
    - Red Cross
    - Salvation Army
    - Religious Organizations
    - Other NGO's
  - Determine EmComm needs of above
    - Modes
    - Frequencies
      - FM voice
      - Packet
      - Other digital
    - Special Forms
      - ICS forms
      - Internal agency forms
      - Ham radio WebEOC resource request form URL <https://ares-mo.org/forms/sema-resource-form/>
  - EOC Communications
    - Equipment
    - Operators
    - WebEOC online information sharing and resource request tracing
  - Deployment of resources
    - Operators
      - Training and Skill level
      - Equipment
      - Operating modes
    - Available repeaters

# Missouri Section ARES®

## Digital Data Communications Resource Guide 2020

- Local Net Control
  - NCS operators and alternates
  - Coordination with other nets

### District ARES

- ❖ Inventory of District wireless assets
  - Create inventory of WiFi Hot Spots for possible use --- Starbucks, McDonalds, other sites
  - Create Inventory of digipeaters in District
    - Location
    - Frequencies
    - Portable digipeaters
      - Availability
      - Where stored or pre-deployment site
  - Designated Net Control/Relay Station(s)
    - Established in coordination with District OES as applicable
- ❖ Existing Networks
  - Winlink Nodes
  - MESH
  - FSQCall
  - MESN (Voice)
  - Others
- ❖ District Digital Go Kit
  - Operator-supplied computer with digital programs installed, sound card modems, TNC, interconnecting cables, HF/VHF/UHF antennas
  - Tool kit for installation & repair including soldering iron
  - SO-239 connectors, PL-259, BNC connectors, others
  - Coax or other feedline
  - Power Supplies: 13.8vdc (shore power), solar, batteries/chargers

For comprehensive lists of go-kit contents consider the following links:

<http://races.org/gokit.htm#disaster>

[www.emergencyradiogokit.com/](http://www.emergencyradiogokit.com/)

[www.harc.net/programs/amateur-radio-go-kit.pdf](http://www.harc.net/programs/amateur-radio-go-kit.pdf)

<https://www.pinterest.com/wcgems/ham-radio-gobox-designs/>

See Also:

- ARRL ARES Field Resources Manual for "Go" kits information
  - Appendix C below
- 
- ❖ List of emergency contacts:
    - ARRL Field Organization managers/coordinators as applicable
    - Served agencies
    - Others

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Appendix D – Sample Go-Kit Contents

1. Dual-band HT in padded belt case and/or mobile.
2. HF radio with internal/external sound card, tuner, HF antenna(s), power source(s)
3. Copy of current FCC Operating License.
4. Extra high-capacity (1000 ma) nicad, or backup AA battery case for HT.
5. DC adapter & cigarette plug cord for HT
6. Two sets of spare fuses (2A, 10A, 15A, 25A)
7. Roll up dual band HT antenna – N9TAX.com Slim Jim antenna
8. Earphone and/or speaker mike
9. Swiss Army knife
10. Multi-purpose tool
11. Mini-Mag-Lite, extra bulb and spare AAs
12. Pencil and pocket notepad
13. Emergency money - small bills and change.
14. SO-239 to BNC adapters (male/female)
15. SMA to BNC adapters (male/female)
16. 6 ft. to 10 ft. RG8-X jumper w/BNC male and female connectors
17. Small pocket compass
18. Folding chair/stool
19. Operating reference card for HT
20. ARES phone and frequency reference card
21. Small Tool Kit: Compact soldering iron, solder, needle nose pliers, screwdrivers, wire strippers, side cutters, Anderson Power Poles & Crimper.
22. 8 pack of AA alkaline batteries as running spares
23. Comfort, safety and basic first aid items: sunglasses, matches, tissues, toothbrush, sun block, sewing kit, insect repellent, tweezers, band-aids, adhesive tape, gauze pads, wound cleaning wipes, toilet paper, bottled water, spare eye glasses of current prescription etc.
24. Digital kit: Operator-supplied computer with digital programs installed, sound card modems, TNC, interconnecting cables, HF/VHF/UHF antennas, 13.8V power supply-batteries-solar.
25. For comprehensive lists of go-kit contents consider the following links:
26. <http://races.org/gokit.htm#disaster>
27. [www.emergencyradiogokit.com/](http://www.emergencyradiogokit.com/)
28. [www.harc.net/programs/amateur-radio-go-kit.pdf](http://www.harc.net/programs/amateur-radio-go-kit.pdf)
29. <https://www.pinterest.com/wcgems/ham-radio-gobox-designs/>